

# Row Spacing and Seeding Rate: Management Practices that Influence Flax Production<sup>1</sup>

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## ABSTRACT

A three year study (1988–90) assessed the potential of row spacing and seeding rate to maintain flax yield in the presence of weeds. Flax seed yield was measured in three row spacings (9, 18 and 27 cm) and three seeding rates (300, 600 and 900 seeds m<sup>-2</sup>) of flax. Poor growing conditions in 1988 and 1989 resulted in small differences in flax seed yield among row spacings, seeding rates and types of weed competition. In 1990, a 900–seeds m<sup>-2</sup> seeding rate increased seed yield in those types of weed competition that had the lowest average seed yield. A 9–cm row spacing increased seed yield in the absence of broadleaf weeds. Mechanisms of competition and practical implications of the results are discussed.

## INTRODUCTION

There is growing concern about problems associated herbicide use in agricultural systems (Thill et al. 1991). Producers may reduce herbicide use either by eliminating broadleaf weed herbicides, grassy weed herbicides or both. If no other method of weed control were used, the elimination of broadleaf and grassy weed herbicides use could result in grassy and broadleaf weed competition.

Flax (*Linum usitatissimum* L.) is a weak competitor with weeds (Burrows and Olson 1955; Friesen et al. 1990). Previously conducted research suggests that, in the presence of weeds, narrowing row spacing (Alessi and Power 1970) and increasing seeding rate (Gruenhagen and Nalewaja 1969) can increase flax seed yield. Prairie flax producers generally use seeding implements with 15–18 cm row spacings. Flax is commonly sown at rates of 600–800 seeds m<sup>-2</sup>.

Increasing pressure to reduce herbicide use and the fact that row spacing and seeding rate can change competitive ability of flax with weeds were the initiatives for a study. The objective of this study was to determine the influence that changes in row spacing and seeding rate, from commonly used spacings and rates, would have on flax yield in the presence of types of weed competition.

## MATERIALS AND METHODS

A study with three trials (1988–90) was conducted on fallow at Melfort, Saskatchewan in the Thick Black Soil Zone. Individual trials incorporated a split-plot design with four replicates. Four types of grassy and broadleaf weed competition were allocated to the main-plots (Table 2). A 3 x 3 factorial combination of flax (cv. NorLin) row spacings and seeding rates was allocated to the sub-plots (Table 1). Sub-plots allocated in strips across the main-plots (Cochran and Cox 1950).

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<sup>1</sup> Paper presented at the 1992 Soils and Crops Workshop, February 21<sup>st</sup>, University of Saskatchewan, Saskatoon, Saskatchewan.

Table 1. Treatment design: types of weed competition, row spacings and seeding rates in the main- and sub-plots within individual trials.

Main-plots	Sub-plots	
Types of weed competition <sup>z</sup>	Row spacings	Seeding rates
Tank-mix <sup>x</sup> $\Rightarrow$ None = NW	9 cm	300 seeds m <sup>-2</sup>
MCPA-Bromoxynil $\Rightarrow$ Grassy = GW	18 cm	600 seeds m <sup>-2</sup>
Sethoxydim $\Rightarrow$ Broadleaf = BW	27 cm	900 seeds m <sup>-2</sup>
None $\Rightarrow$ Grassy/Broadleaf = G/BW		

<sup>z</sup>  $\Rightarrow$  Shows the type of weed competition that results with combinations of broadleaf and grassy weed herbicides that are commonly used in prairie flax production.

<sup>y</sup> The following codes will be used for the remainder of the paper.

<sup>x</sup> Tank-mix of MCPA-Bromoxynil and Sethoxydim.

Trials were conducted at three different sites within 10 km of Melfort. Each trial was cultivated and harrow-packed to provide a smooth firm seed-bed. Monoammonium phosphate (11-51-0) was banded at a rate of 30 kg-P ha<sup>-1</sup> and depth of 5 cm prior to seeding. No additional N was applied. Flax was seeded with a 1.25 m wide two-rank double-disk press drill. The same drill was used to band 11-51-0. Trials were seeded May 13 in 1988, May 10 in 1989 and May 23 in 1990. Depth of seeding varied from 2.5 to 4.0 cm.

Post-emergent herbicides were used to establish 5.5 m wide types of weed competition from weeds emerging from the soil seed bank. Sethoxydim at a rate of approximately 2.0 l ha<sup>-1</sup> was used to control grassy weeds. Broadleaf weeds were controlled with an application of MCPA-Bromoxynil at a rate of 1.0 l ha<sup>-1</sup>. A tank-mix of Sethoxydim and MCPA-Bromoxynil was used to control both grassy and broadleaf weeds. A bicycle sprayer, calibrated to apply 100 l ha<sup>-1</sup> of water, was used to spray the herbicides when flax was 5-8 cm in height. No herbicide was applied to main-plots with G/BW. Hand-weeding was used in herbicide-treated plots to maintain types of weed competition throughout the rest of growing season. In each trial, dominant weed species were recorded.

At maturity, flax, grassy weeds and broadleaf weeds were separately counted and clipped at ground-level within a 0.8 m x 0.5 m quadrat in each plot. Measurements excluded the two outside rows of each plot and were adjusted for the area associated with different row spacings.

Flax yield samples were air dried at 40-50°C and weighed to determine dry matter yield. Weed yield samples were air dried at 70-80°C and weighed to determine dry matter yield. A plot combine was used to thresh seed from dried flax samples. Seed samples were cleaned and weighed to determine seed yield.

Within individual trials, contrast comparisons were used to compare means (Chew 1976). A 18-cm row spacing and 600-seeds m<sup>-2</sup> seeding rate are considered to be the most commonly used row spacing and seeding rate for flax producers. Therefore, comparisons

were made to the 18-cm row spacing and 600-seeds  $\text{m}^{-2}$  seeding rate. Standard error (SE) and  $\text{LSD}_{0.05}$  are presented as measures of precision.

## RESULTS AND DISCUSSION

Average flax seed yield in 1990 ( $152 \text{ g m}^{-2}$ ) was approximately 2.5 times that in 1988 ( $61 \text{ g m}^{-2}$ ) and 3.5 times that in 1989 ( $42 \text{ g m}^{-2}$ ). Poor growing conditions in 1988 and 1989 were the result of low soil moisture reserves and lower than average growing season precipitation.

The effect of row spacing and seeding rate on flax seed yield in 1988 and 1989 was small and in most comparisons not significant ( $P > 0.05$ ). Therefore, the remainder of the paper will focus mostly on the results in 1990.

In 1990, wild oat (*Avena fatua* L.) was the dominant grassy weed species, and cleavers (*Gallium aparine* L.), lambsquarters (*Chenopodium album* L.), pale smartweed (*Polygonum lapathifolium* L.), wild buckwheat (*Polygonum convolvulus* L.) and wormseed mustard (*Erysimum cheiranthoides* L.) were the dominant broadleaf weed species. Grassy weed density was  $23 \pm 9$  (SE) plants  $\text{m}^{-2}$  and dry matter yield was  $65 \pm 32 \text{ g m}^{-2}$  when averaged over GW and G/BW. Broadleaf weed density was  $23 \pm 6$  plants  $\text{m}^{-2}$  and dry matter yield was  $40 \pm 15 \text{ g m}^{-2}$  when averaged over BW and G/BW.

Grassy weeds appeared to affect flax seed yield more than broadleaf weeds. When averaged over GW and G/BW, flax seed yield was 81 % of that in NW. Average seed yield in BW was similar to that in NW.

Flax seed yield in a 9-cm row spacing was 20 % higher than in an 18-cm row spacing when averaged over NW and GW (Table 2). This trend was less pronounced with broadleaf weeds present. Average seed yield in a 27-cm row spacing was similar to that in an 18-cm row spacing regardless of types of weed competition (Table 2). The effect of row spacing, in the present study, was similar to that noted by Alessi and Power (1970).

Table 2. Average flax seed yield in three row spacings and four types of weed competition in 1990.

Row spacing	Types of weed competition			
	NW	GW	BW	G/BW
	----- Flax seed yield <sup>2</sup> ( $\text{g m}^{-2}$ ) -----			
9 cm	193	157	173	149
18 cm	161	130	159	134
27 cm	158	134	146	124

<sup>2</sup> Flax seed yield was averaged over three seeding rates and four blocks in 1990. The  $\text{LSD}_{0.05}$  for the row spacing x types of weed competition interaction, with 12 df, was 13.

Flax seed yield in a 300-seeds  $\text{m}^{-2}$  seeding rate was 15 % less than that in a 600-seeds  $\text{m}^{-2}$  seeding rate when averaged over all type of weed competition (Table 3). Average seed yield in a 900-seeds  $\text{m}^{-2}$  seeding rate, when compared to a 600-seeds  $\text{m}^{-2}$  seeding rate, was 9



% higher with GW and 13 % higher with G/BW (Table 3). These results agree with those reported by Gruenhagen and Nalewaja (1969)

Table 3. Average flax seed yield in three seeding rates and four types of weed competition in 1990.

Seeding rate	Types of weed competition				Mean
	NW	GW	BW	G/BW	
	----- Flax seed yield <sup>2</sup> (g m <sup>-2</sup> ) -----				
300 seeds m <sup>-2</sup>	152	120	140	117	132
600 seeds m <sup>-2</sup>	176	144	165	136	155
900 seeds m <sup>-2</sup>	184	157	173	153	167

<sup>2</sup> Flax seed yield was averaged over three row spacings and four blocks in 1990. The LSD<sub>0.05</sub> for main effect of seeding rate, with 9 df, was 9. The LSD<sub>0.05</sub> for the seeding rate x types of weed competition interaction, with 12 df, was 13.

### Mechanisms of competition

In the presence of weeds, average seed yields of a flax in either a 9-cm row spacing or, 600- and 900-seeds m<sup>-2</sup> seeding rates were more similar to those noted with NW, than in either 18- and 27-cm row spacings or 300-seeds m<sup>-2</sup> seeding rate. Narrower row spacings reduced intra-row competition and higher seeding rates have more plants. For these reasons, flax was able to attain maximum biomass earlier in the growing season in either a 9-cm row spacing or 600- and 900-seeds m<sup>-2</sup> seeding rates.

With BW and G/BW, leafy broadleaf weeds might have interfered with the ability of a 9-cm row spacing to reduce intra-specific competition for light. This provides some explanation why a 9-cm row spacing, when compared to 18-and 27-cm row spacings, increased average seed yield more with NW and GW.

Flax plants in a 300-seeds m<sup>-2</sup> seeding rate may have grown slow enough, when compared to 600- and 900-seeds m<sup>-2</sup> seeding rates, that flax and weeds were not able competing intensely with each other. Therefore, the difference in average seed yield between a 300- and 600-seeds m<sup>-2</sup> seeding rates was independent of types of weed competition. With weeds present, a 900-seeds m<sup>-2</sup> seeding rate might have used resources that weeds would might have used in a 600-seeds m<sup>-2</sup> seeding rate. Without weeds, the growth rate of flax in 900-seeds m<sup>-2</sup> seeding rate may have been such that intra-specific competition for resources became important. This provides some explanation as to why differences in seed yield between 600- and 900-seeds m<sup>-2</sup> seeding rates were dependent on types of weed competition.

The competitive mechanisms that affected 1990 flax seed yields in different row spacings and seeding rates were not effective in 1988-89. Perhaps low soil moisture availability in 1988-89 may have affected the competitive mechanisms responsible for seed yield.

### Practical Implications

Results of the present study suggest that flax producers with air seeders or other seeding implements that have row spacings wider than 15-18 cm should not expect reduced flax seed

yield, regardless of the type of weed competition. To assess the economics of narrower row spacings and higher seeding rates, when weeds are present, narrow-row drill costs, and herbicide and seed costs should be accounted for. Also, variability due to growing conditions and weed seed bank composition variability will make generalizations difficult.

#### **ACKNOWLEDGEMENTS**

Financial support was provided by the Flax Council of Canada.

#### **LITERATURE CITED**

- Alessi, J. and Power, J.F. 1970. Influence of row spacing, irrigation and weeds on dryland flax yield, quality and water use. *Agron. J.* 62:635-637.
- Burrows, V.D. and Olson, P.J. 1955. Reaction of small grains to various densities of wild mustard and the results obtained after their removal with 2,4-D or by hand. II. Experiments with flax. *Can J. Plant Sci.* 35:193-201.
- Chew, V. 1976. Comparing treatment means: A compendium. *Hort. Sci.* 11:348-357.
- Cochran, W.G. and Cox, G.M. 1950. *Experimental Designs*. J. Wiley and Sons, London.
- Friesen, L., Morrison, I.N., Marshall, G. and Rother, W. 1990. Effects of volunteer wheat and barley on the growth and yield of flax. *Can. J. Plant Sci.* 70:1115-1122.
- Gruenhagen, R.D. and Nalewaja, J.D. 1969. Competition between flax and wild buckwheat. *Weed Sci.* 17:380-384.
- Thill, D.C., Lish, J.M., Callihan, R.H. and Bechinski, E.J. 1991. Integrated weed management—A component of integrated pest management: A critical review. *Weed Tech.* 5:648-656.